

We Claim:

1. Apparatus for detecting a level of a surface of a liquid in a container having an upper opening, the apparatus comprising:

a support housing adapted to mate with the upper opening of the container;

primary liquid level sensing means mounted in said support housing for non-intrusively measuring the level of the surface of the liquid in the container; and

secondary liquid level sensing means mounted in said support housing for intrusively sensing a predetermined level of the surface of the liquid in the container for preventing accidental overflows in the event of a malfunction of the primary liquid level sensing means.

2. The apparatus of Claim 1, wherein said primary liquid level sensing means comprises an optical sensor device mounted in said support housing for non-intrusively measuring the level of the surface of the liquid in the container, said optical sensor device including a light emitting device for projecting incident light on the surface of the liquid in the container, and a light detecting device for detecting said incident light reflected from the surface of the liquid in the container.

3. The apparatus of Claim 1, wherein said primary liquid level sensing means comprises an ultrasonic level measuring system.

4. The apparatus of Claim 1, wherein said primary liquid level sensing means comprises means for determining the level of the surface of the liquid in the container by determining a timed flow of liquid into the container.

5. The apparatus of Claim 1, wherein said secondary liquid level sensing means comprises a pair of short fixed electrically conductive probes extending to said predetermined level in said container when said support housing is mated to the upper opening of the container.

6. The apparatus of Claim 1, wherein the container and the liquid in the container are electrically conductive, and said secondary liquid level sensing means comprises a first electrically conductive probe movably mounted to said support housing and adapted to extend to a predetermined level within the container, and a second electrically conductive probe adapted to contact the container, whereby electrical continuity between said first and second electrically conductive probes indicates that the level of the surface of the liquid in the container has reached the predetermined level within the container.

7. The apparatus of Claim 1, wherein the liquid in the container is electrically conductive, and said secondary liquid level sensing means comprises first and second electrically conductive probes movably mounted to said support housing and adapted to extend to a predetermined level within the container, whereby electrical continuity between said first and second electrically conductive probes indicates that the level of the surface of the liquid in the container has reached the predetermined level within the container.

8. The apparatus of Claim 1, wherein the container and the liquid in the container are electrically conductive, and said secondary liquid level sensing means comprises an electrically conductive probe movably mounted to said support housing and adapted to extend to a predetermined level within the container, and means adapted to contact the container to ground the container, whereby electrical continuity between said electrically conductive probe and ground indicates that the level of the surface of the liquid in the container has reached the predetermined level within the container.

9. Apparatus for detecting a level of a surface of a liquid in a container having an upper opening, that apparatus comprising:

- a support housing adapted to mate with the upper opening of the container;
- an optical sensor device mounted in said support housing for non-intrusively measuring the level of the surface of the liquid in the container, said optical sensor device including a light emitting device for projecting incident light on the surface of the liquid in

the container, and a light detecting device for detecting said incident light reflected from the surface of the liquid in the container; and

protective lenses placed in front of the light emitting device and the light detecting device.

10. The apparatus of Claim 9, wherein said light emitting device comprises an infrared emitting diode, and said a light detecting device comprises a phototransistor.

11. The apparatus of Claim 9, wherein said light emitting device is positioned in said support housing to project light at an angle that is about 10° to 80° off vertical when said support housing is mounted to the upper opening of the container.

12. The apparatus of Claim 9, wherein said light emitting device is positioned in said support housing to project light at an angle that is about 37° off vertical when said support housing is mounted to the upper opening of the container.

13. The apparatus of Claim 9, wherein said light detecting device is positioned in said support housing to receive said incident light at an angle that is about 37° off vertical when said support housing is mounted to the upper opening of the container.

14. The apparatus of Claim 9, wherein said light emitting device and said light detecting device are positioned in said support housing so as to project and receive said incident light at an included angle of about 74°.

15. The apparatus of Claim 9, wherein said protective lenses are permanently and hermetically secured on the support housing housing.

16. The apparatus of Claim 9, wherein said protective lenses are incorporated in said support housing housing.

17. The apparatus of Claim 9, wherein each of said protective lenses have an outer surface that is inclined with respect to the vertical, to allow condensation to flow off the protective lenses.

18. The apparatus of Claim 9, wherein each of said protective lenses have an outer surface that is inclined at about 10° to 80° with respect to the vertical, to allow condensation to flow off the protective lenses.

19. The apparatus of Claim 9, wherein each of said protective lenses have an outer surface that is inclined at about 53° with respect to the vertical, to allow condensation to flow off the protective lenses.

20. The apparatus of Claim 9, wherein said protective lenses and said light emitting device and said light detecting device defines a volume in said support housing filled with a dry gas.

21. The apparatus of Claim 9, wherein said protective lenses and said light emitting device and said light detecting device defines a volume in said support housing filled with a vacuum.

22. The apparatus of Claim 9, wherein said protective lenses and said light emitting device and said light detecting device defines a volume in said support housing filled with a solid translucent material.

23. Apparatus for detecting a level of a surface of a liquid in a container having an upper opening, the apparatus comprising:

- a support housing adapted to mate with the upper opening of the container;
- at least one primary liquid level sensing probe movably mounted in said support housing for measuring the level of the surface of the liquid in the container.

24. The apparatus of Claim 23, further comprising a secondary liquid level sensing probe fixedly mounted in said support housing for sensing a predetermined level of the

surface of the liquid in the container for preventing accidental overflows in the event of a malfunction of the primary liquid level sensing means.

25. The apparatus of Claim 24, wherein said secondary liquid level sensing means comprises a pair of short fixed electrically conductive probes extending to said predetermined level in said container when said support housing is mated to the upper opening of the container.

26. Apparatus for detecting a level of a surface of a liquid in a server container of a beverage maker for a transport system, said server container having an upper opening, the apparatus comprising:

a support housing adapted to mate with the upper opening of the server container;
primary liquid level sensing means mounted in said support housing for non-intrusively measuring the level of the surface of the liquid in the server container; and
secondary liquid level sensing means mounted in said support housing for intrusively sensing a predetermined level of the surface of the liquid in the server container for preventing accidental overflows in the event of a malfunction of the primary liquid level sensing means.

27. The apparatus of Claim 26, wherein said primary liquid level sensing means comprises an optical sensor device mounted in said support housing for non-intrusively measuring the level of the surface of the liquid in the server container, said optical sensor device including a light emitting device for projecting incident light on the surface of the liquid in the server container, and a light detecting device for detecting said incident light reflected from the surface of the liquid in the server container.

28. The apparatus of Claim 26, wherein said primary liquid level sensing means comprises an ultrasonic level measuring system.

29. The apparatus of Claim 26, wherein said primary liquid level sensing means comprises means for determining the level of the surface of the liquid in the server container by determining a timed flow of liquid into the server container.

30. The apparatus of Claim 26, wherein said secondary liquid level sensing means comprises a pair of short fixed electrically conductive probes extending to said predetermined level in said server container when said support housing is mated to the upper opening of the server container.

31. The apparatus of Claim 26, wherein the server container and the liquid in the server container are electrically conductive, and said secondary liquid level sensing means comprises a first electrically conductive probe pivotally mounted to said support housing and adapted to extend to a predetermined level within the server container, and a second electrically conductive probe adapted to contact the server container, whereby electrical continuity between said first and second electrically conductive probes indicates that the level of the surface of the liquid in the server container has reached the predetermined level within the server container.

32. The apparatus of Claim 26, wherein the liquid in the server container is electrically conductive, and said secondary liquid level sensing means comprises first and second electrically conductive probes movably mounted to said support housing and adapted to extend to a predetermined level within the server container, whereby electrical continuity between said first and second electrically conductive probes indicates that the level of the surface of the liquid in the server container has reached the predetermined level within the server container.

33. The apparatus of Claim 26, wherein the server container and the liquid in the server container are electrically conductive, and said secondary liquid level sensing means comprises an electrically conductive probe movably mounted to said support housing and adapted to extend to a predetermined level within the server container, and means adapted to contact the server container to ground the server container, whereby electrical continuity between said electrically conductive probe and ground indicates that the level of the surface of the liquid in the server container has reached the predetermined level within the server container.

34. Apparatus for detecting a level of a surface of a liquid in a server container of a beverage maker for a transport system, said server container having an upper opening, that apparatus comprising:

a support housing adapted to mate with the upper opening of the server container;
an optical sensor device mounted in said support housing for non-intrusively measuring the level of the surface of the liquid in the server container, said optical sensor device including a light emitting device for projecting incident light on the surface of the liquid in the server container, and a light detecting device for detecting said incident light reflected from the surface of the liquid in the server container; and

protective lenses placed in front of the light emitting device and the light detecting device.

35. The apparatus of Claim 34, wherein said light emitting device comprises an infrared emitting diode, and said a light detecting device comprises a phototransistor.

36. The apparatus of Claim 34, wherein said light emitting device is positioned in said support housing to project light at an angle that is about 10° to 80° off vertical when said support housing is mounted to the upper opening of the server container.

37. The apparatus of Claim 34, wherein said light detecting device is positioned in said support housing to receive said incident light at an angle that is about 10° to 80° off vertical when said support housing is mounted to the upper opening of the server container.

38. The apparatus of Claim 34, wherein said light emitting device is positioned in said support housing to project light at an angle that is about 37° off vertical when said support housing is mounted to the upper opening of the server container.

39. The apparatus of Claim 34, wherein said light detecting device is positioned in said support housing to receive said incident light at an angle that is about 37° off vertical when said support housing is mounted to the upper opening of the server container.

40. The apparatus of Claim 34, wherein said light emitting device and said light detecting device are positioned in said support housing so as to project and receive said incident light at an included angle of about 74° .

41. The apparatus of Claim 34, wherein said protective lenses are permanently and hermetically secured on the support housing housing.

42. The apparatus of Claim 34, wherein said protective lenses are incorporated in said support housing housing.

43. The apparatus of Claim 34, wherein each of said protective lenses have an outer surface that is inclined with respect to the vertical, to allow condensation to flow off the protective lenses.

44. The apparatus of Claim 34, wherein each of said protective lenses have an outer surface that is inclined at about 10° to 80° with respect to the vertical, to allow condensation to flow off the protective lenses.

45. The apparatus of Claim 34, wherein each of said protective lenses have an outer surface that is inclined at about 53° with respect to the vertical, to allow condensation to flow off the protective lenses.

46. The apparatus of Claim 34, wherein said protective lenses and said light emitting device and said light detecting device defines a volume in said support housing filled with a dry gas.

47. The apparatus of Claim 34, wherein said protective lenses and said light emitting device and said light detecting device defines a volume in said support housing filled with a vacuum.

48. The apparatus of Claim 34, wherein said protective lenses and said light emitting device and said light detecting device defines a volume in said support housing filled with a solid translucent material.

49. Apparatus for detecting a level of a surface of a liquid in a server container of a beverage maker for a transport system, said server container having an upper opening, the apparatus comprising:

- a support housing adapted to mate with the upper opening of the server container;
- at least one primary liquid level sensing probe movably mounted in said support housing for measuring the level of the surface of the liquid in the server container.

50. The apparatus of Claim 49, further comprising a secondary liquid level sensing means fixedly mounted in said support housing for sensing a predetermined level of the surface of the liquid in the server container for preventing accidental overflows in the event of a malfunction of the primary liquid level sensing means.

51. The apparatus of Claim 50, wherein said secondary liquid level sensing means comprises a pair of short fixed electrically conductive probes extending to said predetermined level in said server container when said support housing is mated to the upper opening of the server container.

52. A method for detecting a level of a surface of a liquid in a container having an upper opening, the method comprising the steps of:

- providing a support housing adapted to mate with the upper opening of the container;

- providing a liquid level sensing means mounted in said support housing for non-intrusively measuring the level of the surface of the liquid in the container;

- intermittently providing power to at least a portion of the liquid level sensing means such that the liquid level sensing means operates periodically.

53. The method of Claim 52, wherein said liquid level sensing means comprises an optical sensor device mounted in said support housing for non-intrusively

measuring the level of the surface of the liquid in the container, said optical sensor device including a light emitting device for projecting incident light on the surface of the liquid in the container, and a light detecting device for detecting said incident light reflected from the surface of the liquid in the container, and said step of intermittently providing power to the liquid level sensing means comprises:

intermittently providing power to the light emitting device such that the light emitting device operates periodically, whereby the liquid level can be detected periodically.

54. The method of Claim 53, wherein said step of intermittently providing power to the liquid level sensing means further comprises monitoring the phototransistor only when power is provided to the light emitting device.